Carolina Weather Service," Hon. A. P. Butler, Commissioner of Agriculture for South Carolina, director:

The month has been cool and dry, with temperature and rainfall both below the average. At Charleston the mean temperature was 54°.8, or 2°.4 below the mean of the last sixteen years, and the total rainfall was only .50 inch, or 3.68 inches less than the average for the same period.

The mean temperature for the entire state was 51°.4, or 1°.2 lower than that of the preceding month. The average rainfall was 1.85 inches, being 1.56 inches less than that for February.

The opening days of the month were warm and pleasant, but after the general rains which occurred on the 8th and 9th cool west to northwest and north winds set in and continued with more or less regularity until the 20th. After that date the winds became variable and there was a gradual increase of temperature until the 28th, when a sudden fall occurred and the northwest winds again predominated.

As a whole the month was unfavorable for truck gardening and fruit growing interests, the cool winds referred to having chilled the plants and stunted their growth.

The heaviest rainfall of the month occurred throughout the state on the 8th and 9th, and was accompanied by a marked decrease of temperature, these conditions probably causing the formation of the area of low barometer which appeared off the North Carolina coast on the 9th, and which moved slowly northeastward along the coast until the 11th, when it reached Nova Scotia. The northwest and west winds which prevailed over our state until the 20th were due to the presence of an extensive area of low barometer central over the Atlantic Ocean and off the coasts of New England and Nova Scotia from the 11th to the 20th.

During the 21st an area of low barometer passed within the limits of our state. This storm developed in Louisiana on the 20th and passed eastward along the Gulf coast into southern Georgia; thence northeastward along the South Carolina coast during the 21st. The storm increased in severity during its northeasterly movement and caused violent winds on the middle Atlantic and New England coasts. It was followed in this state by brisk west and north winds and clear weather.

The temperature fell suddenly in our state during the night of the 28th, the reports showing a decrease in temperature of 25° to 30° between 2 p. m. of the 28th and the same hour on the 29th.

The following telegram from the Chief Signal Officer of the Army, at Washington, D. C., was received at Columbia at 11.30 a. m. on the 28th:

"WASHINGTON, D. C., *March* 28.

"*To Observer, Columbia, S. C.:*

"Hoist cold-wave signal. The temperature will probably fall suddenly twenty degrees by 7 a. m. Tuesday.

"(Signed) GREELY."

A few minutes later the following was received:

"WASHINGTON, D. C., *March* 28.

"*To Observer, Columbia, S. C.:*

"Severe frosts are expected in the interior of South Carolina, Georgia, and Alabama on the morning of the 29th.

"(Signed) GREELY."

This information was immediately distributed, through the co-operation of the railroads and by special telegrams, throughout the state, so that at 1 p. m., or several hours in advance of the cold wave, by energetic effort on the part of those whose interests were liable to damage by frost, preparation could have been made to protect plants, gardens, etc. An examination of the reports from display stations shows that this warning was of great benefit to many people, and that such preparations were made, and with successful results, many gardens of early vegetables having been saved from injury.

Summary.

Mean temperature, 51°.4; highest temperature, 82°, at Columbia and Spartanburg, on the 2d; lowest temperature, 23°, at Spartanburg, on the 19th; range of temperature, 59°; greatest daily range of temperature, 43°, at Florence, on the 1st; Cheraw, on the 2d; and Spartanburg, on the 26th; least daily range of temperature, 2°, at Newberry, on the 5th.

Mean daily rainfall, 1.85 inches; greatest monthly rainfall, 3.89 inches, at Abbeville; Least monthly rainfall, 0.50 inches, at Charleston; greatest daily rainfall, 1.47 inches, at Bennettsville, on the 8–9th; date of heaviest rainfall throughout the state, 9th. Average number of rainy days, 7.

The following is an extract from the "Tennessee State Board of Health Bulletin" for March, 1887, prepared under the direction of J. D. Plunkett, M. D., President of the State Board of Health. The weather report is prepared by H. C. Bate, Director of the State Meteorological Service:

The mean temperature for March was 49°, slightly above the normal. The highest temperature was 77°, recorded on the 1st and 26th, and was the lowest maximum reported in the five years beginning with 1883. The lowest temperature was 18°, recorded on the 29th, and was the highest minimum reported in the period above-named, the lowest being 5°, reported in 1885. The mean daily range of temperature was very nearly normal.

The state was visited by three cold waves during the month, viz., on the 3–4th, 13–14th, and 27–28th; the predictions of which were all fully verified, the temperature reaching even 5° to 15° below the predictions.

The mean rainfall was 3.79 inches, slightly below the normal, and nearly two inches below the mean of the past five years in March. Of this amount the eastern division received an average of nearly three and three-fourths inches; the middle division nearly four inches, and the western division a little more than three and a half inches. The greatest rainfall was 5.41 inches, reported at Florence Station, and the least was 1.60 inches, reported at Fostoria. The days of the greatest rainfall were the 4th, 6th, 7th, 9th, and 27th; of these, the greatest fall occurred on the 6th, when an average of 1.11 inches fell throughout the state. The greatest local daily rainfall occurred at Florence Station on the 6th, and measured 2.85 inches. But few of the rains were general. Those on the 14th, 17th, 18th, 21st, and 28th were reported with snow; most of them were light and partial. The 1st, 2d, 10th, 11th, 12th, 13th, 15th, 24th, 25th, and 26th were reported without rain. Snow fell in various parts of the state on the 14th, 17th, 18th, 21st, and 28th; most of these falls were very light; the greatest depth reported was at Fostoria, 2 inches.

Summary.

Mean temperature, 49°.0; range of temperature, 59°; mean monthly range of temperature, 49°.5; greatest monthly range of temperature, 56°, at Greeneville and Hohenwald; least monthly range of temperature, 42°, at Covington; mean daily range of temperature, 16°.8; greatest daily range of temperature, 42°, on the 1st, at Grief, and on the 12th, at Hohenwald; least daily range, 1°, on the 4th, at Riddleton, and on the 20th, at Trenton; mean of maximum temperatures, 74°.0; mean of minimum temperatures, 24°.5.

Average number of clear days, 13.4; average number of fair days, 6.7; average number of cloudy days, 10.9; average number of days on which rain or snow fell, 9.4.

Warmest day, 26th; coldest day, 29th.

Prevailing direction of wind, northwest.

METEOROLOGICAL NOTES.

AVERAGE STORM TRACKS FOR THE MONTH OF MARCH.

[By 2d Lieut. FRANK GREENE, Signal Corps, U. S. Army, Assistant.]

In the construction of chart number vii, showing the average storm tracks for the month of March, ninety-nine storm tracks have been considered, the storms occurring in the years from 1873 to 1885. Only those storms were considered whose paths clearly laid within the limits of observation in the United States. Many tracks that only skirted the northern boundary of the United States were not considered, because, owing to the sparsity of stations of observation in the British Provinces, the exact location of the storm-centre was not clearly defined.

Upon examination it is found that these storm-centres pursued, in a general way, paths of such similarity that they may be said to be divided into four classes, the path of each class being distinct and different from the others, and readily discerned.

These paths, as shown on the chart, are designated by the letters *AA*, *BB*, *C C*, *D D*, with secondary paths, *A aa'*, *B bb'*, *C cc'*.

A A. These storms first appear near the northern boundary of the United States, about the one hundred and tenth meridian west from Greenwich, and move southeastward through Montana and Dakota, passing then eastward near the latitude of Saint Paul, Minn., thence crossing Lakes Michigan and Huron, move down the Saint Lawrence Valley, disappearing generally off the Nova Scotian coast. A smaller number, *A aa'*, after following the general direction *A A*, appear to be deflected more to the south after passing Saint Paul, and moving down over Lake Erie disappear to the east of Delaware Bay.

B B. These storms are first noticed in Montana about the one hundred and seventh meridian west from Greenwich, and at once take a more southerly course, southeastward through Nebraska and northern Kansas, passing eastward near Saint Louis, thence inclining gradually to the northward, moving up the Ohio Valley along the southern edge of Lakes Erie and Ontario, and moving down the Saint Lawrence Valley, disappearing near its mouth. A smaller number after first following the general course *B B*, continue in a direct east course after passing Saint Louis, and pass to the eastward, disappearing near the mouth of Delaware Bay.

C C. These storms are first noticed in northwestern Texas between latitudes 32° and 35° N., near the one hundredth meridian west, one portion moving in a direction a little north of east through Arkansas, Tennessee, and southern Virginia, passing off into the Atlantic Ocean south of Norfolk, Va. A slightly greater number, *C cc'*, take at once a course in a nearly direct northeast line through the Indian Territory, Missouri, Illinois, the lower part of eastern Michigan, and following the Saint Lawrence Valley disappear in the Atlantic Ocean near Newfoundland.

D D. These storms appear to originate in the western part of the Gulf of Mexico, in the vicinity of Galveston, Tex., and in general move in a direct northeast course through Louisiana, Mississippi, northern Alabama, east Tennessee, following the trend of the Blue Ridge Mountains and skirting the southern coast of New England, disappear in the Atlantic Ocean about the southern shores of Nova Scotia. Very rarely storms appearing in the Gulf of Mexico are apparently pressed southward by the influence of an area of high barometric pressure in the Mississippi and lower Missouri valleys, and move eastward along the Gulf shores to the Atlantic Ocean, and following the Atlantic coast closely move off into the Atlantic off the Nova Scotian coast; these are so few in number as to occupy no place on the chart.

The relative frequency of storms on the different paths in the month of March is, *A*, 48.5 per cent.; *B*, 22.2 per cent.; *C*, 21.2 per cent.; *D*, 8.1 per cent.

Of the forty-eight storms included in track *A*, but five, or 10 per cent., followed the path of *A aa′*, and these disappeared off the Atlantic coast between North Carolina and Connecticut; twenty-seven, or 57 per cent., disappeared east of the Gulf of Saint Lawrence and north of Massachusetts, and sixteen, or 33 per cent., disappeared north and west of the Gulf of Saint Lawrence.

Of the twenty-two storms composing track *B*, nine, or 40 per cent., pursued the track *B bb′*; eleven, or 50 per cent., disappeared east of the Gulf of Saint Lawrence and north of Massachusetts; one, or 4.5 per cent, disappeared west of the Gulf of Saint Lawrence, and one erratic storm, after dipping as far south as the Gulf of Mexico, disappeared off the coast of South Carolina.

Of the twenty-one storms composing track *C*, eleven, or 52.4 per cent pursued the track *C C*, and disappeared east of the Gulf of Saint Lawrence and north of Massachusetts, and nine, or 42.9 per cent., pursued the track *C cc′* and disappeared east of the Atlantic coast and south of Delaware; of these nine, two moved eastward to the north coast of Florida; one other storm moved eastward along the Gulf coast and afterwards moved up close along the Atlantic coast.

Of the 8 storms composing the track *D*, seven, or 87.5 per cent., disappeared east of the Gulf of Saint Lawrence, and one, or 12.5 per cent., disappeared west of that gulf.

Number of storms of each class which occurred in each year in the month of March.

Class.	Year.													Total.
	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	
A	7	3	5	2	0	1	6	6	2	8	3	3	2	......
B	2	0	1	3	6	0	2	2	3	0	0	2	1	......
C	2	3	3	2	0	1	1	1	3	0	2	2	1	......
D	0	0	2	0	0	1	0	2	0	1	1	1	0	......
Total	11	6	11	7	6	3	9	11	8	9	6	8	4	99

PREDICTION OF FOG NEAR NEWFOUNDLAND.

[By Sergt. E. B. GARRIOTT, Signal Corps.]

The fog-banks which are encountered over, and in the vicinity of, the Banks of Newfoundland constitute the most dreaded feature of trans-Atlantic travel, more particularly during the annual southward movement of the Arctic ice-fields. It is therefore evident that investigations likely to lead to meteorological facts which govern the formation of fog in that region would be of unusual interest to mariners.

In the pursuit of these investigations it is allowable to presume that, with a knowledge of the conditions under which fog is formed, the possibility of foreseeing the development of those conditions would not be remote. The obvious cause of fog formation over the Banks is the intermingling of warm and cold air and water currents. As regards differences in temperature of the water, considered alone, it is not shown that this is the element which contributes to the development of dense fog, and it therefore follows that the air currents constitute the chief auxiliary cause of the more dense formations. The ice-fields necessarily, and very appreciably, lower the temperature of the air in their vicinity, and the amount of moisture precipitated in the form of fog is governed by the differences in temperature of the air currents which intermingle on their margins. A natural sequence to the approval of this theory would be the conclusion that the greater the differences in temperature of opposing air currents the greater the amount of fog precipitated at their point of contact. With this fact granted we have only to ascertain the causes by which masses of air exhibiting great ranges in temperature may be brought together. As has been stated the ice-fields contribute atmosphere exhibiting low temperatures; for the opposing warm air currents it is necessary to consider the position of the Banks with reference to the relative flow of ocean currents and wind-directions calculated to draw into this locality masses of warm air. The principal source of warmth is found in the waters of the Gulf Stream which flow from the southwestward and pass over the southern portion and to the southward of the Great Banks.

The atmosphere over this warm stream is necessarily more humid and warm than that which overlies the adjacent ocean or the neighboring land, and in this fact we have the second condition requisite to the precipitation of fog atoms. It now remains to determine the general meteorological conditions necessary to cause a continued and large intermingling of the fog engendering masses of air. In this connection it is necessary that the wind-directions whereby the atmosphere is propelled must be considered, as this element constitutes the apparent active agent by means of which it is thought that the probable occurrence and location of fog-banks may be foreseen. As herein shown the region of warm, moist air lies to the southward and southwestward of the Banks of Newfoundland, and, as will be readily seen, the wind-directions necessary to force this air upon the colder air over the ice-fields would be included within the southeast and southwest quadrants. As this region embraces an area traversed by a greater portion of the storm-centres which pass eastward from the continent, and which advance, as a rule, over the Great Lakes and along the Saint Lawrence Valley, it is not unreasonable to conclude that, with a knowledge of the laws which govern wind-directions in advance of and within storm-areas, the presence of dense fog over the Banks could be determined with a considerable degree of accuracy.

Recent investigations by the Signal Service have verified the above conclusions with reference to the general conditions under which fog has been encountered over the Banks during the past few months, and it is believed that a further study of the subject will result in the possession of knowledge which will prove of practical benefit to maritime interests.

The voluntary observer at Manatee, Fla., lat. 27° 27′, long. 82° 35′, reports:

"Several farmers have informed me of queer streaks in which frost is appearing. In one field, where tomatoes were planted, every plant was killed, excepting two rows in about the middle of the field. Another farmer noticed in a field of beans that frost killed in spots, the whole field being apparently level. Several others give about the same experience."

Very slight undulations in the surface of the ground would permit the coldest air to settle in the lowest places. Variations in the conditions, quality, color, or constitution of the soil would permit some parts of the field to radiate heat and cool more rapidly than others; variations in the conditions of the plants, so that the sap of some are more easily frozen than others. A trough or general slight incline of the field may cause a flow of air along a few rows of vegetables and save them from freezing. Special parts of the field that are wetter than others will not suffer as much from frost as neighboring dry spots, because the upward conduction of heat prevents the cooling to the freezing point. When such peculiarities are noted by observers they will assist in reaching a solution if they will report in reference to both the frosted and unfrosted places: (1) as to the difference in elevation; (2) whether the soil is light or heavy; (3) whether the surface has been cultivated since rain has fallen; (4) does either portion appear to be more moist than the other; (5) did adjacent bushes or trees protect either portion from the wind, if any; (6) whether the unfrosted parts were near trees; (7) any other relative conditions noticed. [Editor REVIEW.]

Prof. Selin Lemström, the Finnish *savant*, well know for his observations and studies of the aurora, has recently published in Paris the results of his auroral research within the Arctic circle. The following reviews of his work are given:

* * * The view that auroras are due to positive currents of electricity, illuminating the air on their passage to the earth, has been solidly established by M. Lemström's results at Sodankylä, Finland. His "discharging apparatus" served the precise purpose of Franklin's kite. The one experiment was not more decisive than the other. Not only did luminous appearances accompany the setting-in of a current towards the earth from the network of insulated wires spread over the summit of Mount Oratuntura, but the light evoked was distinctly *auroral*. Examined with the spectroscope, it yielded the still enigmatical "citron line" discovered by Angström in 1867. This is the invariable and chief constituent of auroral radiations. Besides one fitfully present, detected by Zöllner in the red, it is the only vivid line its spectrum includes. Ten others, more or less dubiously enumerated, are faint, hazy, indeterminate. M. Lemström says that there is a fair agreement between some of them and the lines in the laboratory-spectrum of rarefied air.—*Nature, vol. 35, page* 435.

* * * The aurora borealis is, we learn, an *electrical* phenomenon in a form different to lightning, but still of an atmospheric nature. At a certain distance from each pole is a belt or zone whence a continuous but varying discharge of electricity into the atmosphere takes place; this is the aurora borealis and australis. This theory is now accepted by all leading *savants* as the only natural explanation of the phenomenon, and it has recently been greatly strengthened by the removal of one important point against it, viz., that electricity could not be transmitted through a vacuum or chamber of rarefied air, an assumption by Prof. Edlund, the celebrated Swedish physicist.

Prof. Lemström demonstrates that the aurora borealis has a double periodicity of about eleven and fifty-six years, and that the terrestrial magnetic storms follow the same laws, and that these, too, strange to say, coincide with those regulating the sun spots.—*London Electrical Review, vol.* 20, *page* 274.

FROST-WARNING SIGNALS.

Superintendent of Telegraph Simpson, of the Chicago, Milwaukee, and Saint Paul Railway, has issued a circular that the company, with a view of protecting the interests of those engaged in the culture of tobacco and cranberries, have made arrangements with the United States Signal Service Department, through Sergeant Rhode, the observer at Milwaukee, to furnish frost warnings to the company from May 1st to October 1st, in each year, for distribution to stations in the cranberry and tobacco-growing regions. A frost signal, consisting of a black flag eight feet square, with a white centre three feet square, has been adopted, and it will be displayed from the top of a flag-pole, where it will be plainly visible from the surrounding country. The company assumes the expense of sending these warnings by telegraph, and the parties interested in the growing of the crops are expected to furnish the flag and display it. * * * The first warning will enable the cranberry growers to flood their marshes, and the tobacco cultivators to build smudges around their fields to keep the frost away. The Saint Paul company is entitled to credit for trouble and expense in securing this favor for the people on its lines.—*Evening Wisconsin, April* 20, 1887.